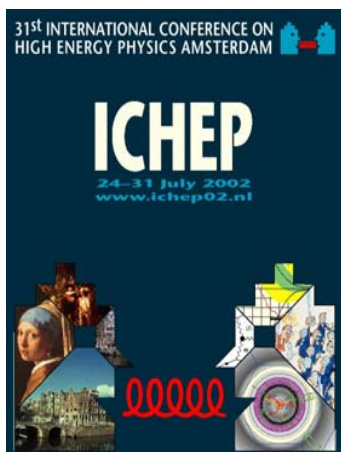


The DØ Detector for Run II

Levan Babukhadia

SUNY at Stony Brook
for the DØ Collaboration



Physics Challenges → The Upgraded Tevatron

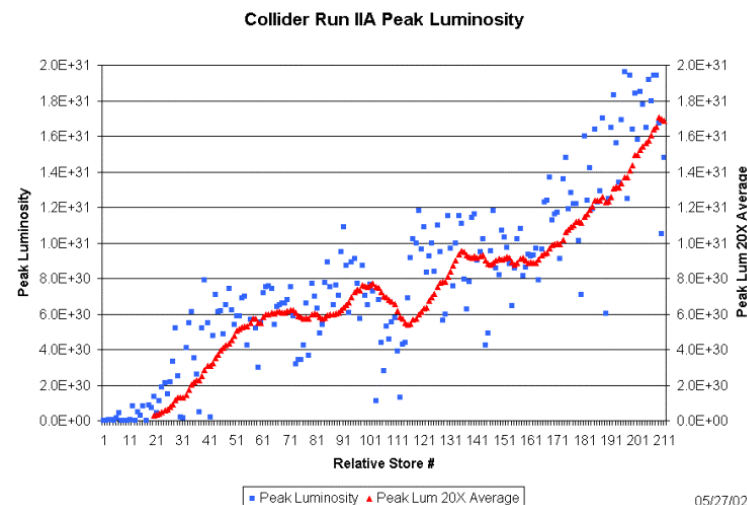
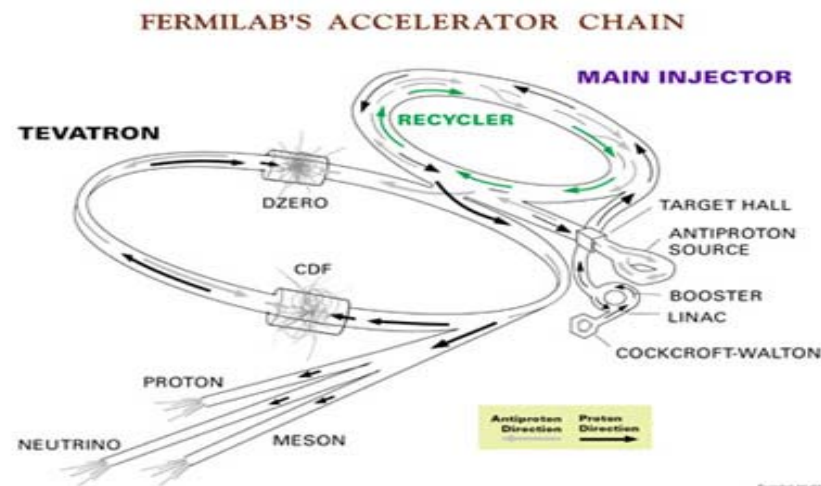
Physics goals for Run 2

- precision studies of weak bosons, top, QCD, B-physics
- searches for Higgs, supersymmetry, extra dimensions, other new phenomena

require

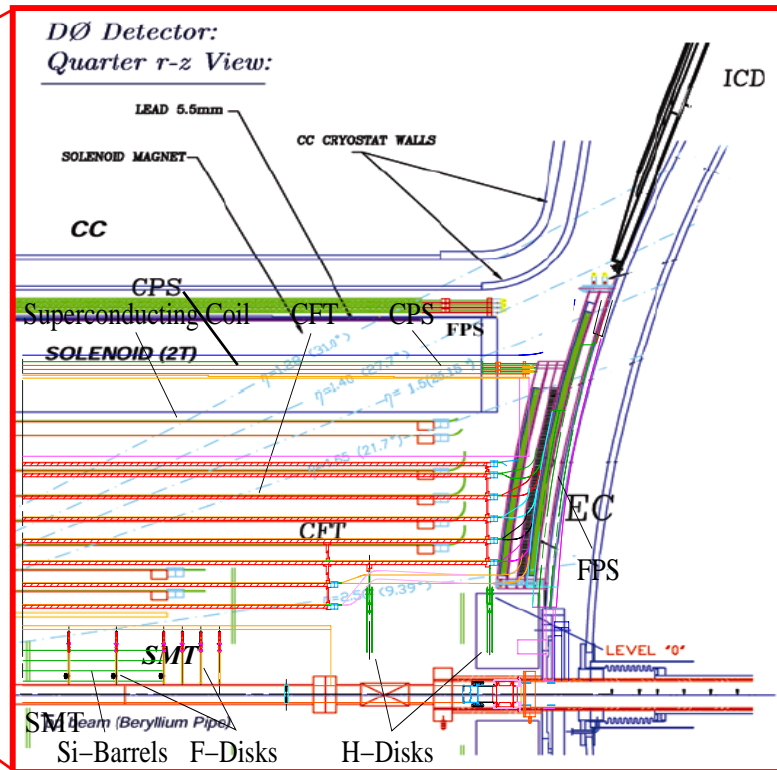
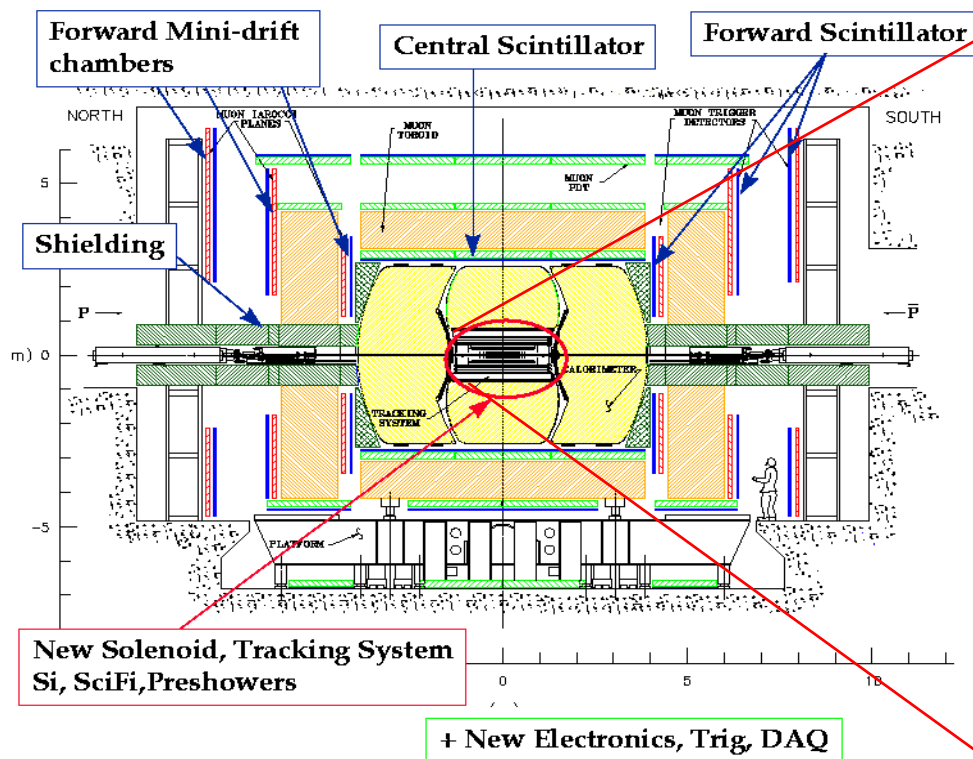
- electron, muon, and tau identification
- jets and missing transverse energy
- flavor tagging through displaced vertices and leptons
- luminosity, luminosity, luminosity...

	Run 1b	Run 2a	Run 2b
Bunches in Turn	6×6	36×36	140×103
\sqrt{s} (TeV)	1.8	1.96	1.96
Typical L ($\text{cm}^{-2}\text{s}^{-1}$)	1.6×10^{30}	8.6×10^{31}	5.2×10^{32}
$\int \text{Ldt}$ ($\text{pb}^{-1}/\text{week}$)	3.2	17.3	105
Bunch xing (ns)	3500	396	132
Interactions / xing	2.5	2.3	4.8
	Run 1 → Run 2a → Run 2b $0.1 \text{ fb}^{-1} \rightarrow 2\text{--}4 \text{ fb}^{-1} \rightarrow 15 \text{ fb}^{-1}$		



Peak Lum. achieved over $2 \times 10^{31} \text{ cm}^{-2}\text{s}^{-1}$
 Planned to reach Run 2a design
 by Spring 2003

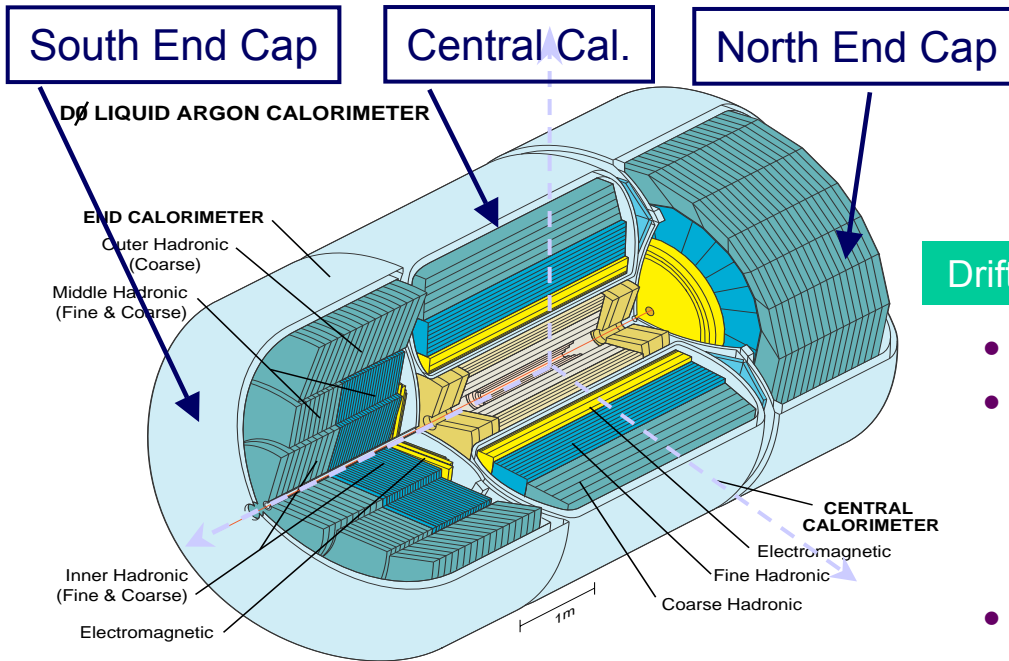
Physics Challenges → The Upgraded Detector



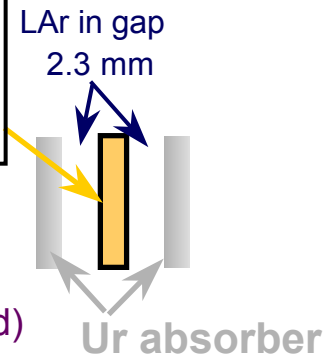
- New tracking devices, Silicon (SMT) and Fiber Tracker (CFT), placed in 2 T magnetic field (see also George Ginther's talk in this session)
- Upgraded Calorimeter electronics readout and trigger

- Added PreShower detectors, Central (CPS) and Forward (FPS)
- Significantly improved Muon System
- New forward proton spectrometer (FPD)
- Entirely new Trigger System and DAQ to handle higher event rate

Calorimeters



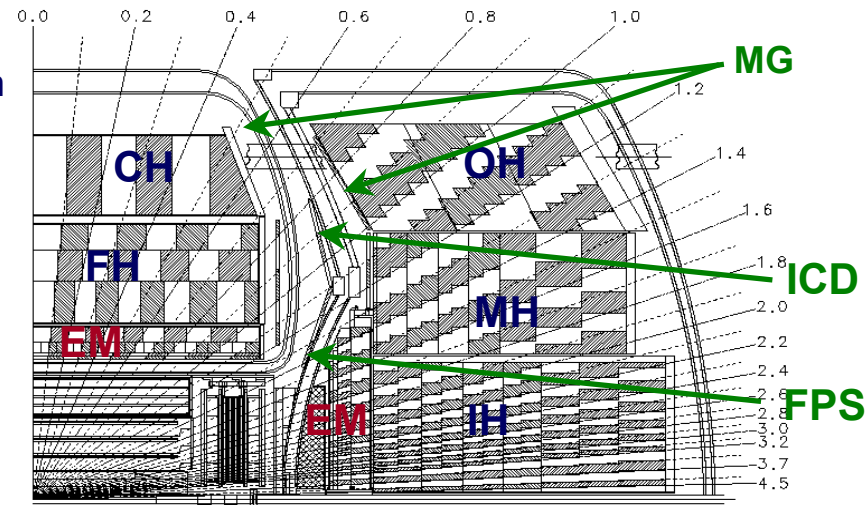
Readout Cell
Cu pad readout on
0.5 mm G10 with
resistive coat epoxy



Drift time ~ 430 ns

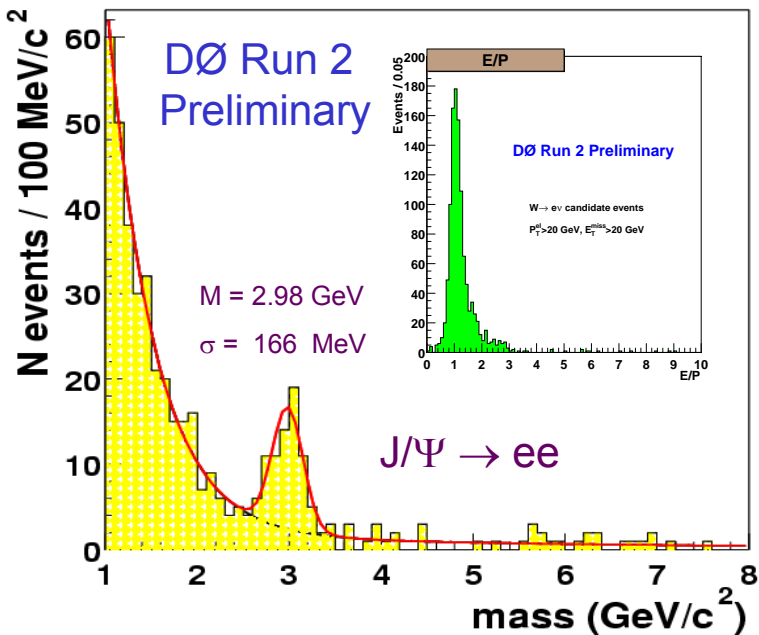
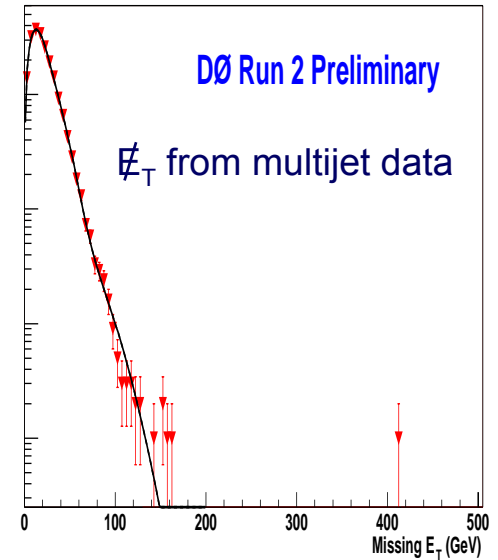
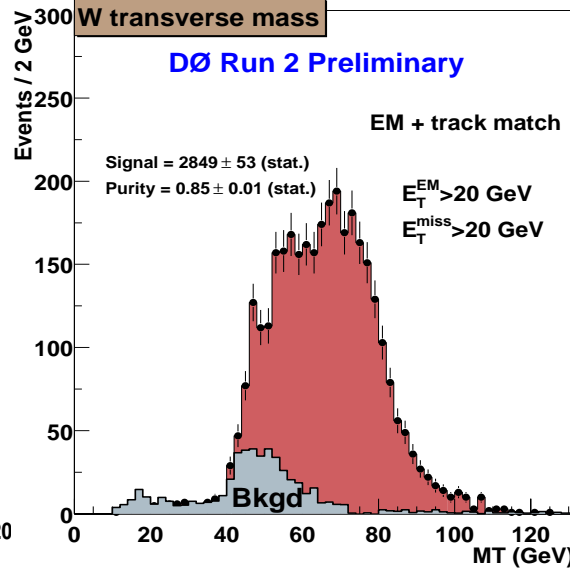
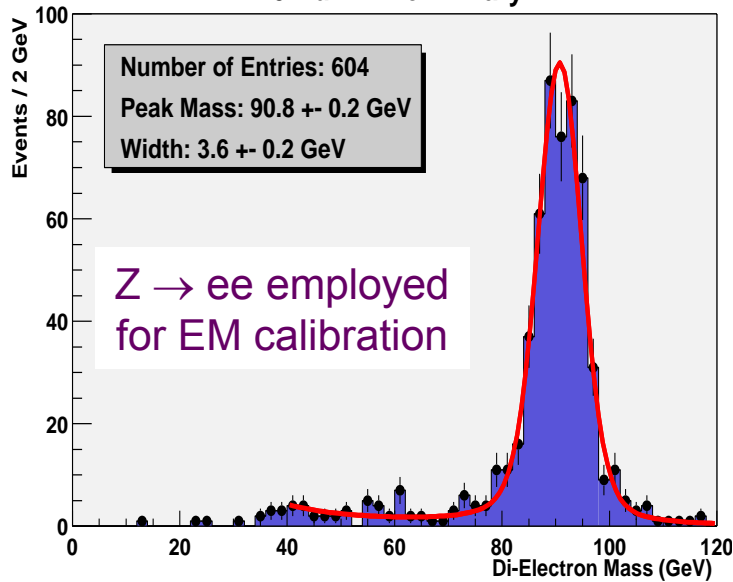
- Liquid Argon sampling
 - uniform response, rad. hard, fine spatial segmentation
 - LAr purity important
- Uranium absorber (Cu/Steel CC/EC for coarse hadronic)
 - nearly compensating, dense \Rightarrow compact
- Uniform, hermetic with full coverage
 - $|\eta| < 4.2$ ($\theta \approx 2^\circ$), $\lambda_{\text{int}} \sim 7.2$ (total)
- Single particle energy resolution
 - e: $\sigma/E = 15\% / \sqrt{E} \oplus 0.3\%$ π : $\sigma/E = 45\% / \sqrt{E} \oplus 4\%$

- 50k readout cells ($< 0.1\%$ bad)
- Fine segmentation
 - 5000 pseudoprojective towers (0.1×0.1)
 - 4 EM layers, shower-max (EM3): 0.05×0.05
 - 4/5 Hadronic (FH + CH)
- L1/L2 fast Trigger readout 0.2×0.2 towers
- Fully commissioned



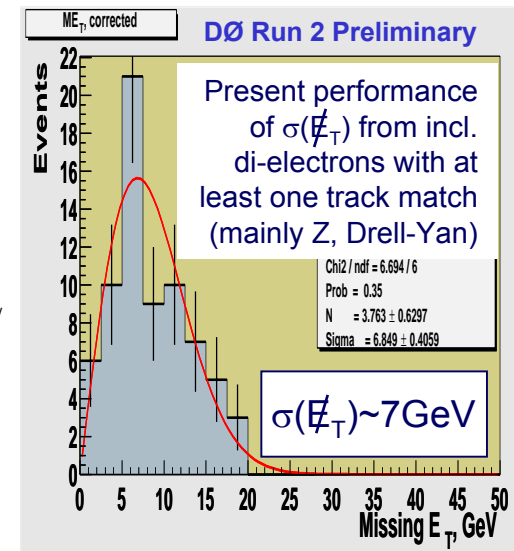
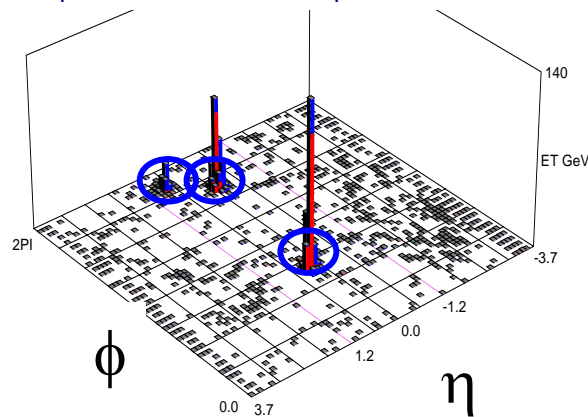
Calorimeter Performance

D0 Run II Preliminary

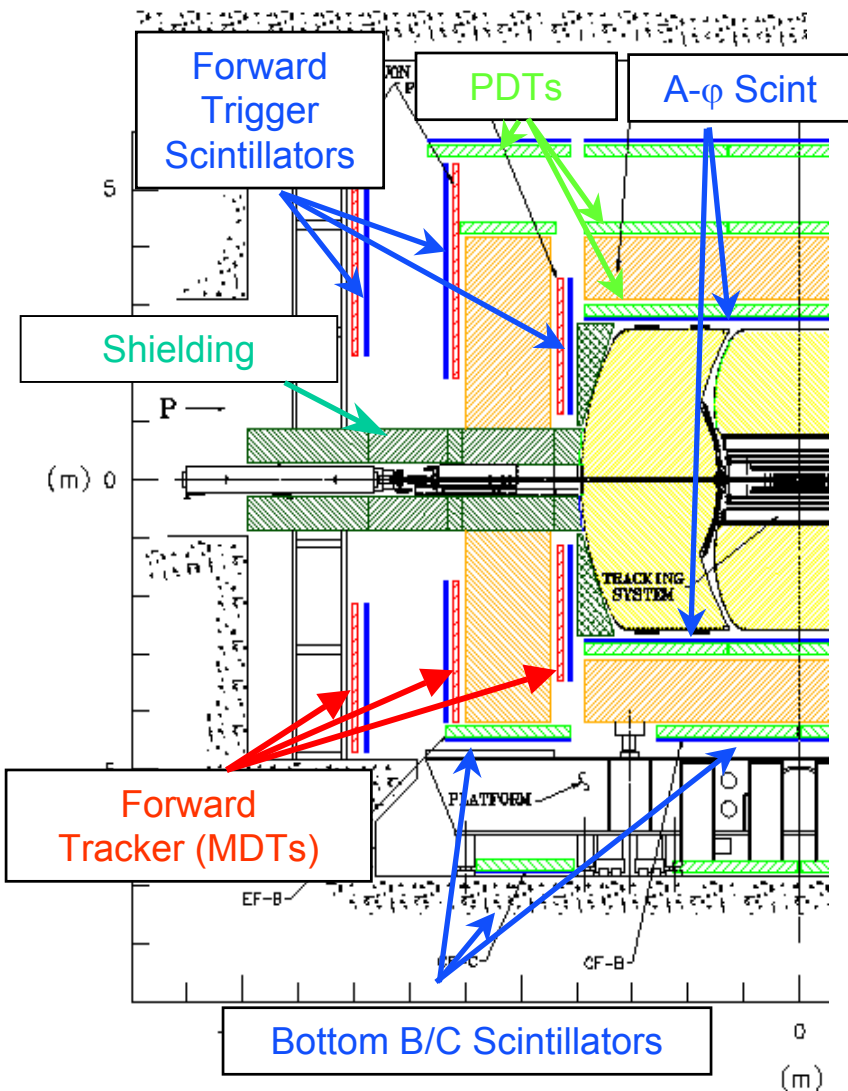


Three-jet event

$E_{T,jet1} \sim 310\text{GeV}$, $E_{T,jet2} \sim 240\text{GeV}$
 $E_{T,jet3} \sim 110\text{GeV}$, $\cancel{E}_T \sim 8\text{GeV}$



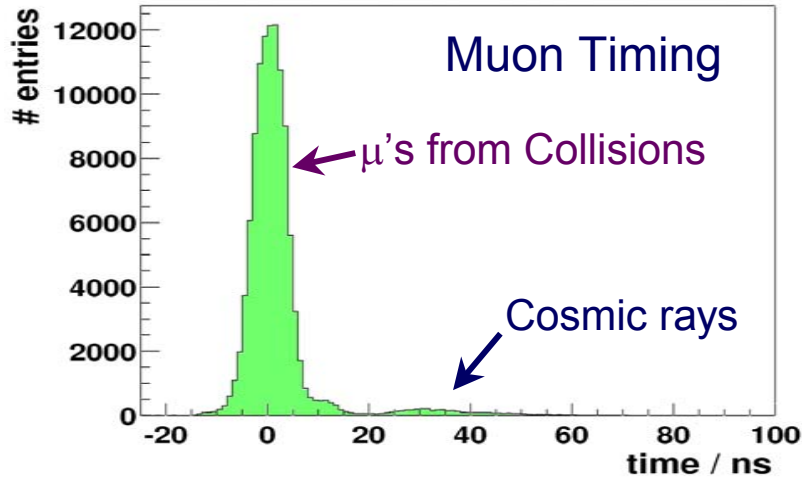
Muon System



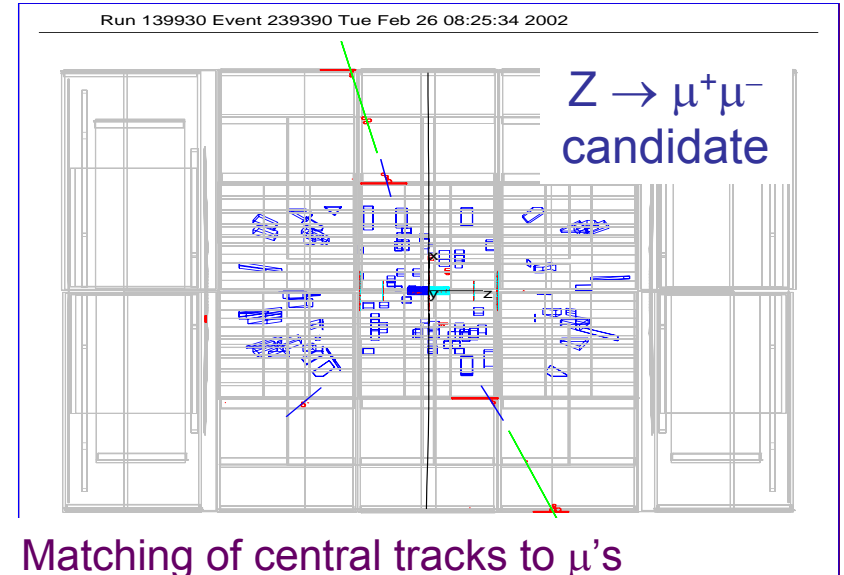
Fully commissioned

- Central and Forward regions, coverage up to $\eta = \pm 2$
- Three layers: one inside (A), two outside (B, C) the toroid magnets
- Consists of scintillators and drift tubes
- Central Proportional Drift Tubes (PDT's)
 - 6624 drift cells (10.1×5.5 cm) in 94 three- and four-deck chambers
- Central Scintillation Counters
 - 360 “cosmic ray” counters outside the toroid ($\Delta\phi = 22.5^\circ$)
 - 630 “A- ϕ ” counters inside ($\Delta\phi = 4.5^\circ$), $\Delta\eta = 0.1$
- Forward Mini Drift Tubes (MDT's)
 - 6080 8-cell tubes in 8 octants per layer on North and South side, cell cross-section 9.4×9.4 mm
- Forward Scintillation Counters (Pixels)
 - 4214 counters on the North and South side
 - $\Delta\phi = 4.5^\circ$ matches the MDT sector size

Muon System Performance

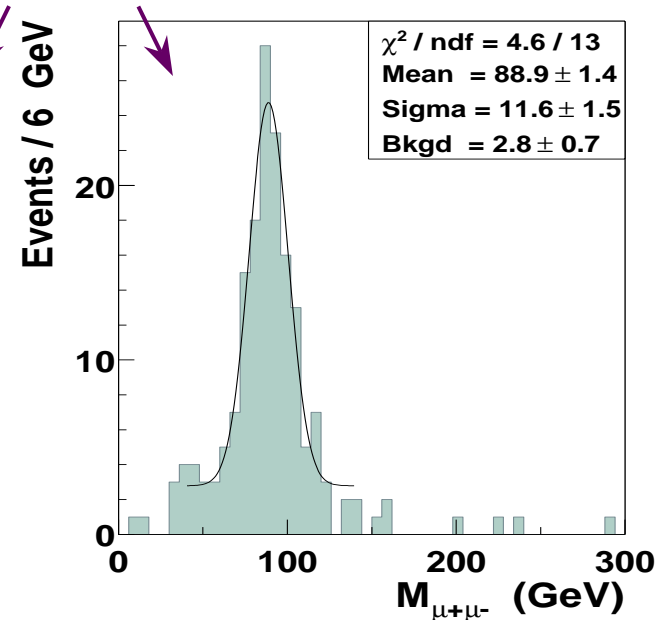
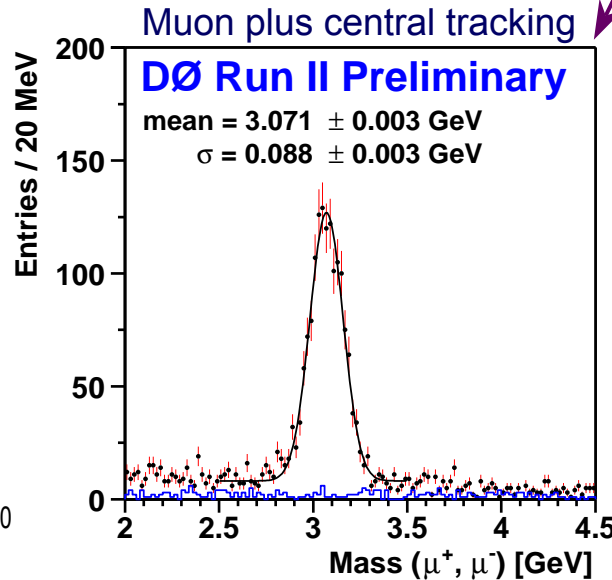
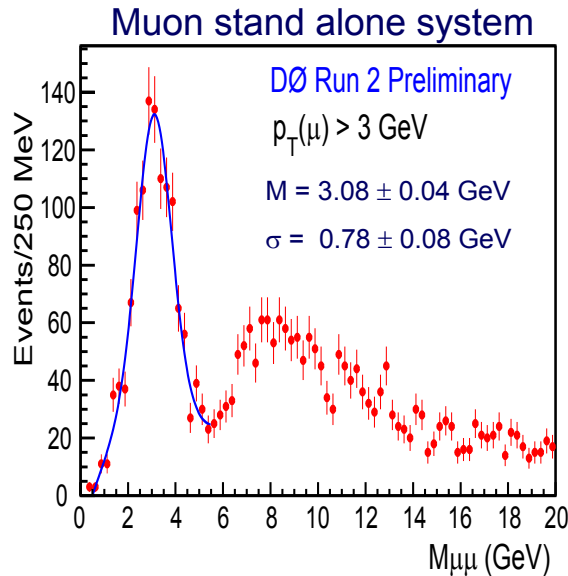


Timing cuts reduce cosmic bckg., could aid in detection of slow moving particles



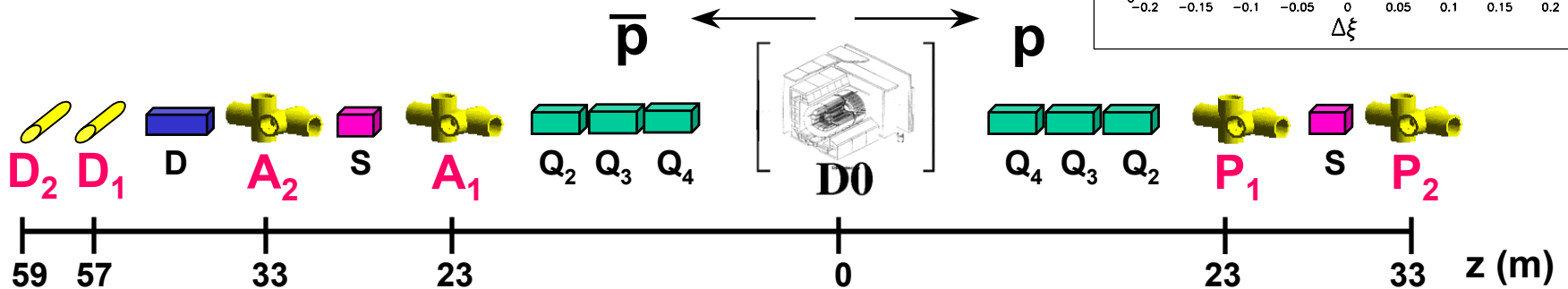
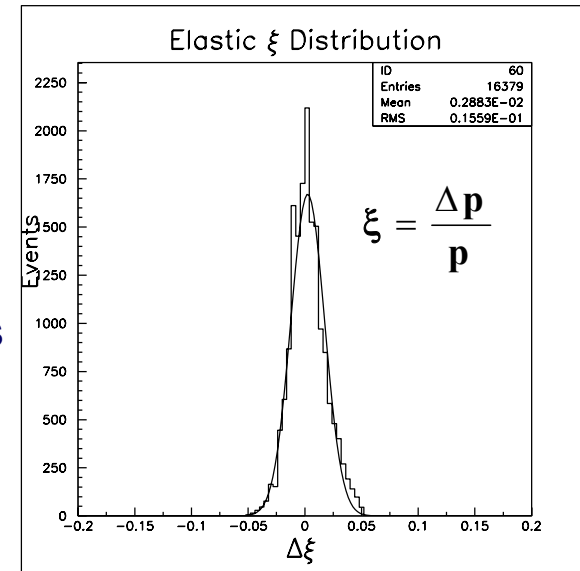
Matching of central tracks to μ 's improves momentum resolution

J/ Ψ invariant mass

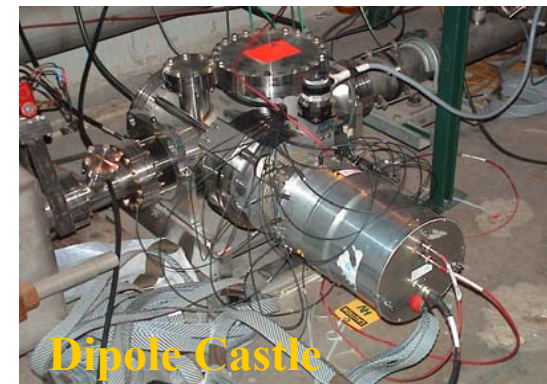


DØ Forward Proton Detector

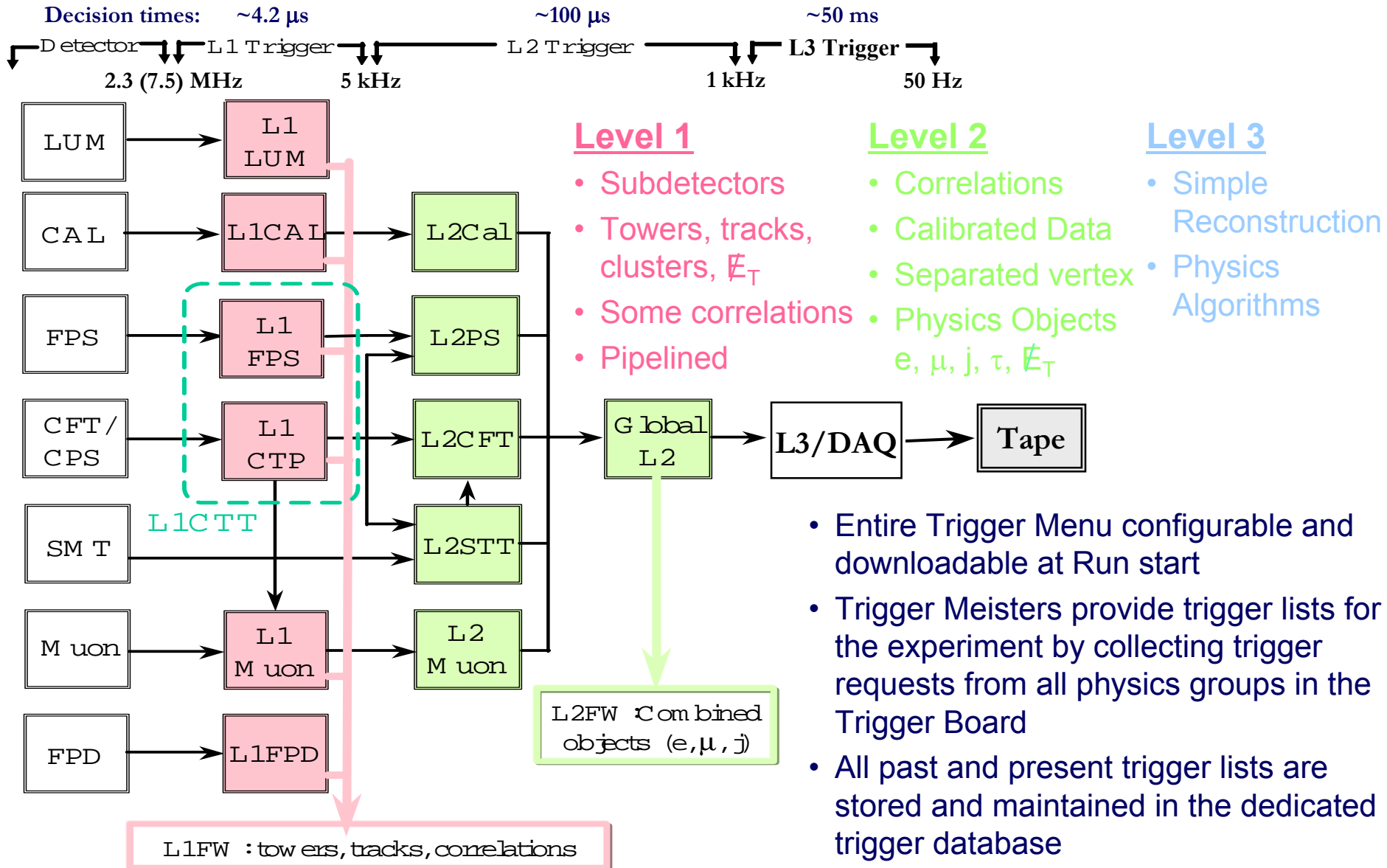
- Diffractive and elastic physics program
 - need special detectors at very small angles: FPD
- FPD consists of 2 arms (outgoing proton and anti-proton)
 - 18 Roman pots in 4 quadrupole and 2 dipole “castles”
- From hits in scintillating fiber detectors installed in Roman pots
 - fractional energy lost by the proton and scattering angle
 - trigger on elastic, diffractive, double pomeron events



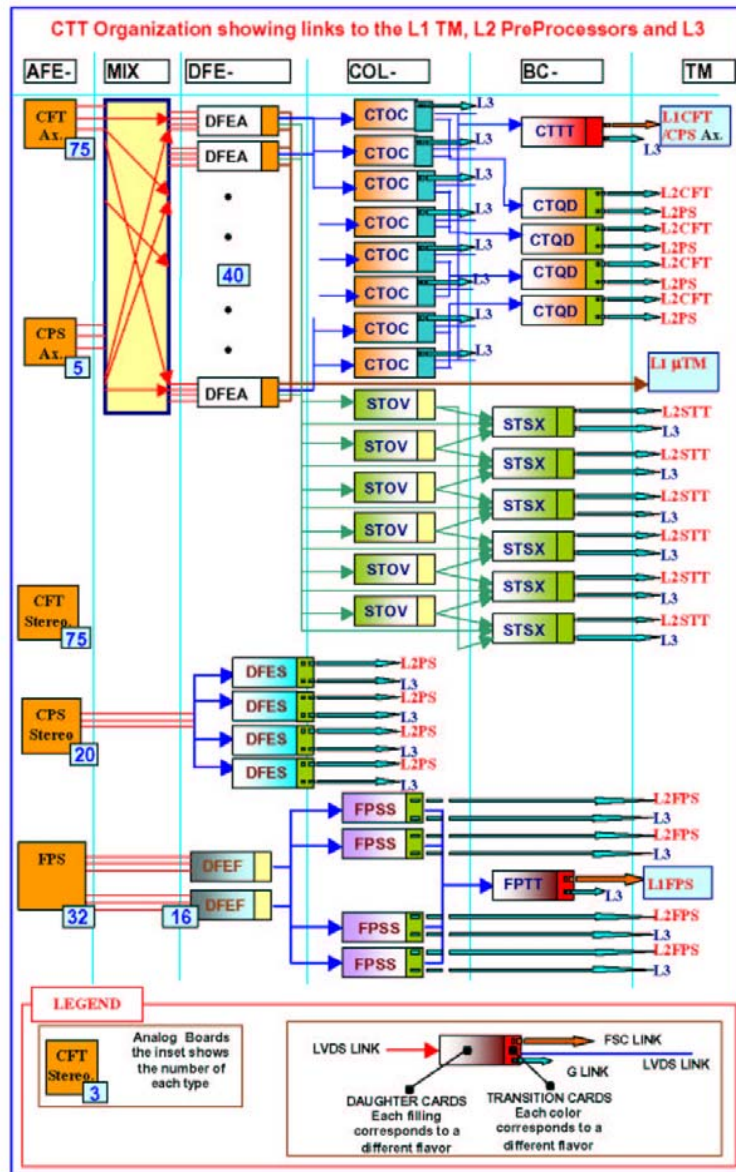
- Routinely insert pots during collisions
- Recorded > 2 M elastic events with stand-alone DAQ
- Working on integration of FPD with the rest of DØ
- First diffractive+jet data by December



DØ Trigger System

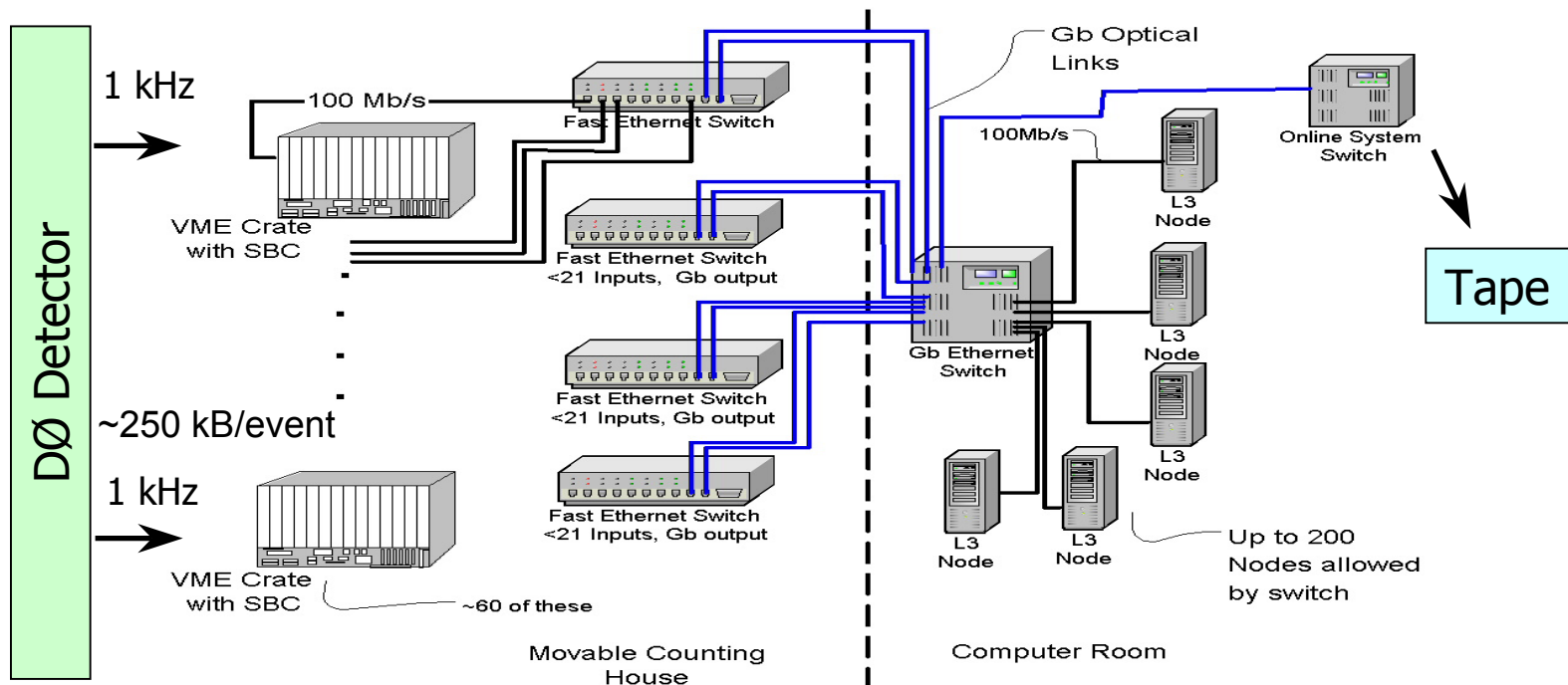


DØ Track and Preshower Digital Trigger



- Implemented in ~100 digital boards with same motherboard and different flavors of daughter-cards with over 500 Xilinx Virtex FPGAs
- Provides charged lepton id in Level 1 by finding tracks in 4.5° azimuthal trigger sectors of CFT
- Helps with EM-id in Level 1 by reconstructing clusters of energy in CPS scintillator strips
- Helps with Muon-id in Level 1 by sending 6 highest p_T tracks to L1Muon in about 900ns
- Helps with EM-id in forward regions $|\eta| < 2.6$ by reconstructing clusters of energy in FPS strips
- Helps with charged lepton id in forward regions by confirmation in pre-radiator layers of FPS
- Facilitates matching of preshower and calorimeter objects at quadrant level
- Helps with displaced vertex id in Level 2 Silicon Track Trigger by providing the Level 1 CFT tracks for global SMT+CFT track fitting
- Currently being commissioned

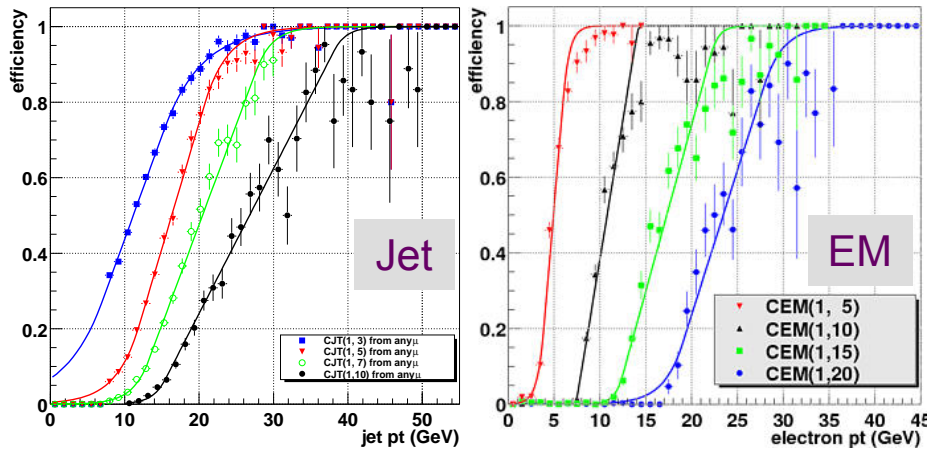
Data Acquisition System



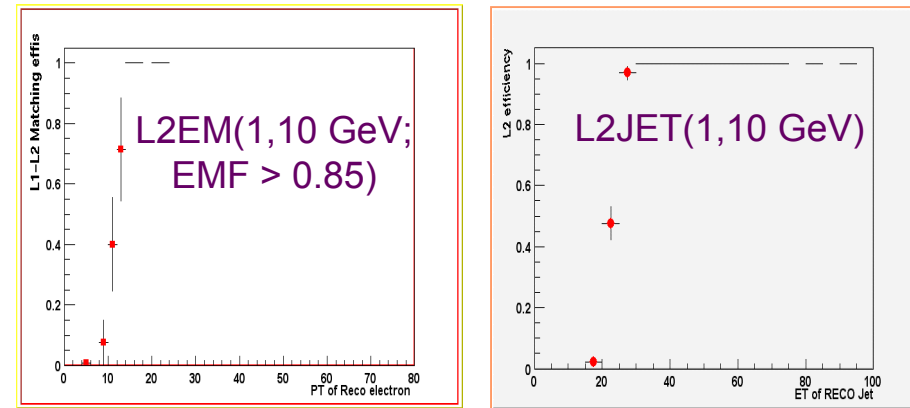
- Gathers raw data from the front-end crates following each Level 2 Accept
- Based on “off the shelf” components
- Single Board Computers (SBCs) read out Level 3 buffers: Intel 1GHz, VME based, dual 100Mb Ethernet, Linux OS
- SBCs send data to a Level 3 node over fast Ethernet switches according to instructions received from the Routing Master
- The routing Master program runs on an SBC in a special crate receiving data from the Trigger Framework
- Cisco Switch sends data to Linux Level 3 Farm nodes
- Event building and Level 3 trigger selections performed by 48-node Linux farm

Level 1 and Level 2 Trigger Performance

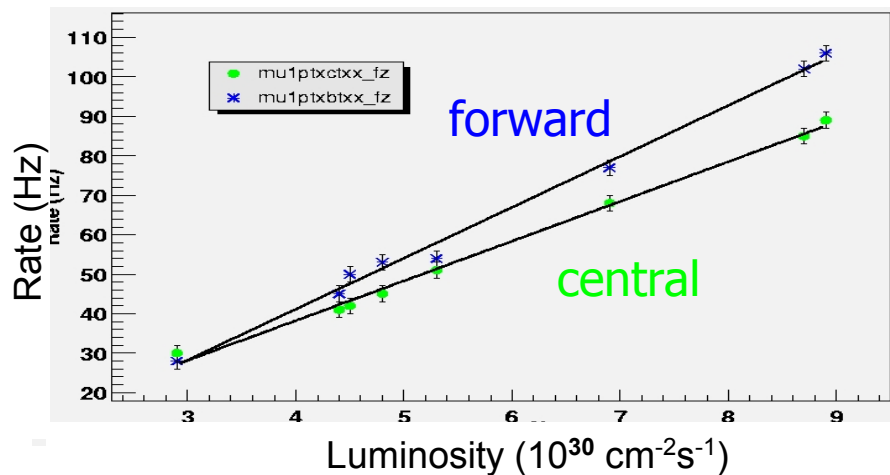
Level 1 Calorimeter Jet and EM trigger “turn-on”s



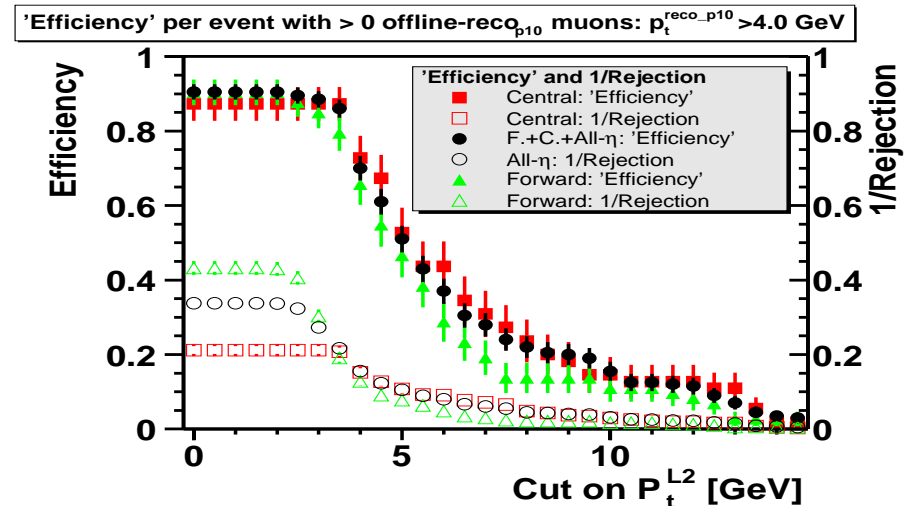
Level 2 Calorimeter Jet and EM trigger efficiencies



Level 1 Muon trigger rate dependence on Luminosity

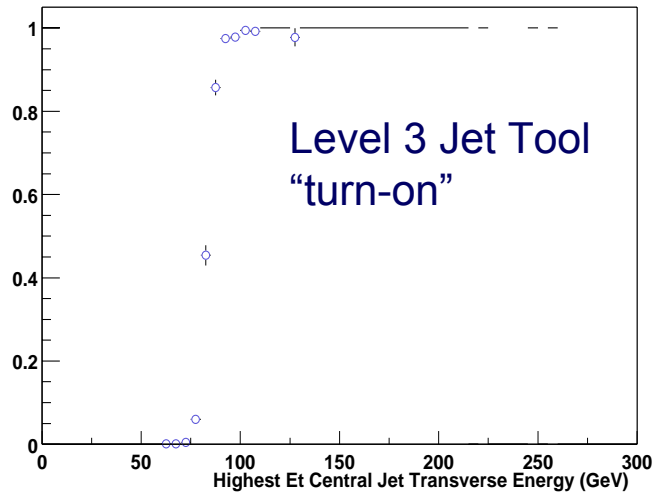


Level 2 Muon trigger efficiency and rejection



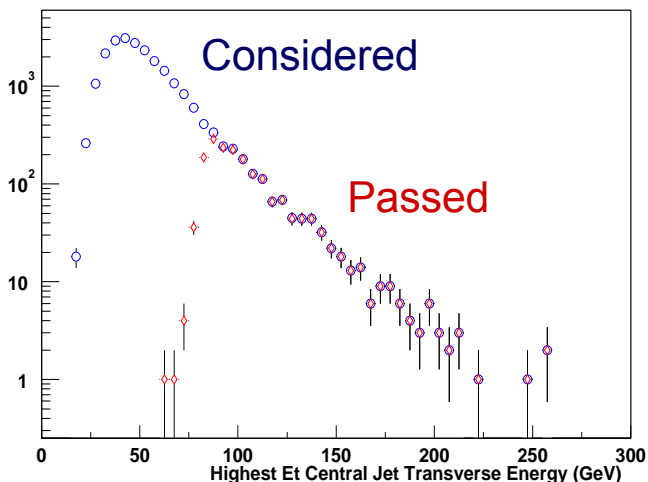
Level 3 Trigger Performance

JT_MX 2C Turn On Curve Using "L3MarkPass"

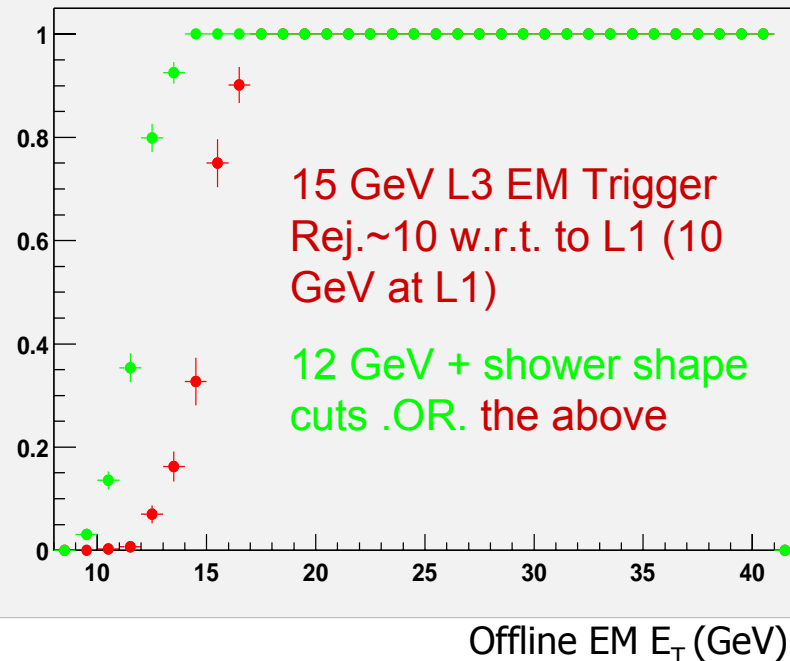


The 48-node Linux Level 3 farm working and selecting events, by triggering on Jets, EM objects, Muons, Taus

JT_MX L3MarkPass bit = 1 2C dataset



ptscceff



DØ Detector Run 2b Upgrade

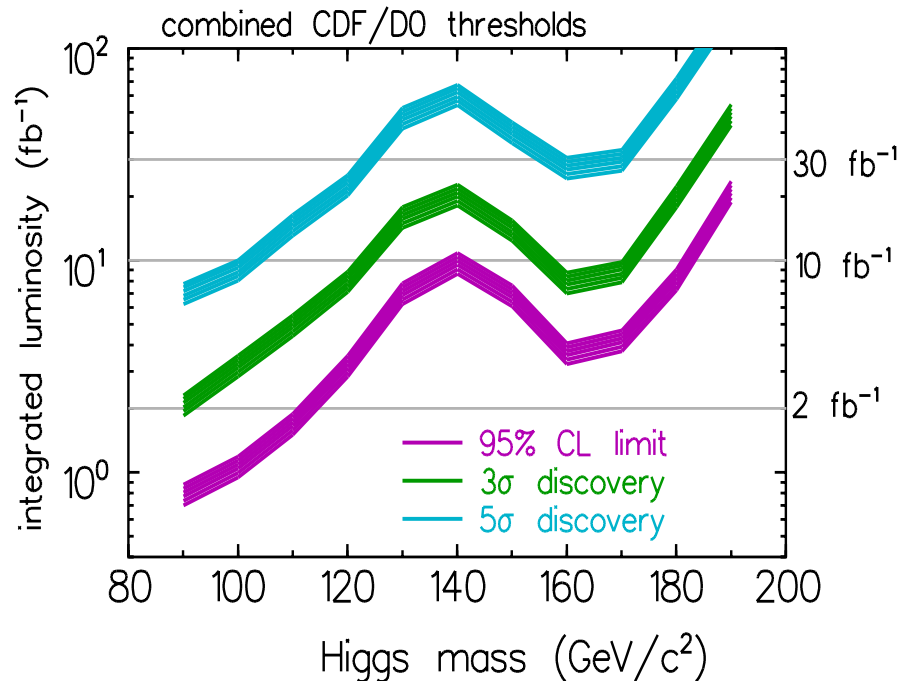
- Present detector was designed for $\sim 2\text{--}4\text{fb}^{-1}$ integrated and $\sim 2 \times 10^{32}\text{ cm}^{-2}\text{s}^{-1}$ instantaneous Luminosity
- Run 2b goal $\sim 15\text{fb}^{-1}$ before LHC Physics
 - Physics motivations: Higgs and Supersymmetry
 - Exceeds radiation tolerance of existing Silicon detector
 - Requires higher instantaneous luminosities, $\sim 5 \times 10^{32}\text{ cm}^{-2}\text{s}^{-1}$, trigger upgrades

Silicon Upgrade

Replace Silicon Detector with a more radiation-hard version

New Silicon tracker with innermost layer at 1.78 cm (c.f. 2.71 in Run 2a)

Maintain good pattern recognition coverage $|\eta| < 2$



Trigger Upgrade

Upgrade L1 Track Trigger to narrow roads, improve Track-Cal. matching

Upgrade L1/2 Cal. Trigger to use digital filter, isolation, shape cuts

Incremental upgrades to Level 2, Level 3 Triggers and online system

Summary and Outlook

- The DØ Detector for Run 2 is operating and collecting physics data
- Enormous progress over the past year in installation, integration, commissioning of the detector and understanding the data
- Performance of the Run 2 DØ detector is very encouraging
 - all subdetectors are operating well
 - software and computing systems are working well
 - we are reconstructing electrons, muons, jets, missing E_T , J/ψ , W 's and Z 's and first results already presented at winter/spring and now at summer conferences
- We are working hard on what still needs to be done
 - complete commissioning of Level 1 Track Trigger
 - improve calibration and alignment
 - integrate Level 2 Silicon Track Trigger later this year
 - optimize detector, trigger, and DAQ performance
 - continue working on Run 2b Upgrade Project
- We are on the way to exciting physics, first physics results coming soon, exciting years are ahead!